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COLLEGE OF ENGINEERING
DEPARTMENT OF ELECTRICAL ENGINEERING
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BERKELEY, CALIFORNIA 94720

30 July, 1993

Dr. Teresa McMullen
800 North Quincy Street
Code 1142PS
Room 823
Division of Cognitive Neurological Sciences
Office of Naval Research
Arlington, VA 22217

Dear Dr. McMullen,

This is our semiannual report of activity on Grant N00014-91-J-1333 during the period from 1 Jan 93 through 30 Jun 93.

The personnel working on project N00014-91-J-1333 during the reporting period were E.R. Lewis (PI), B.H. Bonham (doctoral student, research assistant) and B.R. Parnas (postdoctoral researcher). During this period our efforts were focused on five tasks: (1) modeling studies of the effects of noise on faithful reproduction of temporal waveforms by ensembles of auditory axons, (2) detailed evaluations of the biological plausibilities of the models of Jeffress and Shamma for inferences regarding the direction of a sound-source, (3) modeling studies of stimulus-driven development of binaural circuits in the medial superior olive and (based on those studies) construction of a biologically-feasible alternative to the Shamma and Jeffress models, (4) development of a cochlear-filter model based on observations of reverse correlation functions (first-order Wiener kernels), using a format similar to that of Carney and Yin, and (5) continued writing of the chapter on computations involving time.

In task (1) we confirmed Knight's (1972) hypothesis that the presence of noise makes possible faithful reproduction of temporal waveforms in the aggregate activity of a population of spike-initiator (or axon) models. We also verified Stein's (1970) hypothesis that *for a given range of stimulus frequencies and amplitudes, an optimal level of neuronal variability will exist that permits efficient transmission of information with only a small amount of distortion.* In tasks (2) and (3) we found that computations equivalent to those carried out by the Shamma and Jeffress models can be accomplished without invoking either axonal time delays (Jeffress) or cross-frequency comparison (Shamma) both of which have aroused some consternation in the auditory physiology/anatomy communities. A paper on this topic is in preparation for J Acoust Soc Am.

In the coming six months we intend to complete all of the studies undertaken so far and to submit papers on each of them to archival journals. We also will make the software we have developed on this project available to anyone who wants to use it. Mr. Bonham will complete the requirements for his doctoral degree by December. The PI will be busy conducting field research in the late fall, but intends to continue to use the interactive software developed on this project on much of his future research on processing of temporal waveforms by the auditory periphery and brainstem.

Sincerely yours,

Edwin R. Lewis

Bibliography:

Knight BW (1972), Dynamics of encoding in a population of neurons. *J. General. Physiol.*, 59: 734-766.

Stein RB (1970), The role of spike trains in transmitting and distorting sensory signals, in **The Neurosciences: 2nd Study Program**, F.O. Schmitt, ed., pp. 597-604, Rockefeller University press.

Publications:

Bonham BH and Lewis ER (in press) Self-organization and properties of receptive fields in the auditory brainstem - a modeling approach. Proceedings of the 1993 Computational Neural Systems Conference.

Bonham BH and Lewis ER (in prep) Without further delay: an alternative model for neural computations based on interaural time differences. (for J Acoust Soc Am).

Bonham BH and Lewis ER (submitted) Development of sound-source localization by interaural time/phase difference - a model <abstract to neurosciences>

Parnas BR (submitted) Analysis of the response properties of a computationally efficient spike initiator model. Biol Cybern

Parnas BR (in press) The effects of neuronal modeling parameters on the auditory nerve image: an exploration of parameter space. Proceedings of the 1993 Computational Neural Systems Conference.

cc: Administrative Grants Officer
Director, Naval Research Laboratory
Defense Technical Information Center